Space Weather Technical Forecast

Issued on Thursday 28 November 2024 at 12:27 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: Low to Moderate Activity. CME arrival Day 1 or Day 2 (28-29 Nov) with potential for G1-G2 Minor/Moderate Storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate in the past 24 hours, with the peak activity M1.0 observed at 27/1246UTC from the vicinity of AR3911 in the southwest. There are nine active regions currently on the Earth-facing disc. The largest of these are AR3905 and AR3906 in centre disc, with some interaction likely between the two regions, however these have remained relatively inactive. Also of note is AR3910 in the northeast, which was the source of an M9 flare from over the northeast limb. This appears to be a relatively simple group, dominated by a main spot, with much smaller satellites, however this remains difficult to assess due to its location. A new region emerging onto the southeast limb may be one region or two separate regions - for the time being it is classified as one region but this may change as it moves into a clearer viewing angle. The other regions are generally smaller and simpler, with no sign of notable growth or development.

A filament eruption was observed off the southeast disc at 27/1850 UTC in H-alpha imagery, with a subsequent CME becoming visible on recent SOHO coronagraphs, heading south and east. This is expected to pass mostly below Earth's orbit, perhaps with some glancing influence on 02 Dec. No other Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: Solar winds, measured by ACE and DSCOVR at L1, were at background levels. Wind speeds were around 350-400km/s with density around or below average. Interplanetary Magnetic Field, Bt, was mostly weak, just peaking at 8nT. The north-south component, Bz, varied weakly between +/-6nT. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background levels. The associated 24-hour fluence remained well below the Active threshold. The integrated flux observed at 28/0000 UTC was 2.04e6 total pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with isolated M-class flares likely. There is a slight chance of X-class flares.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

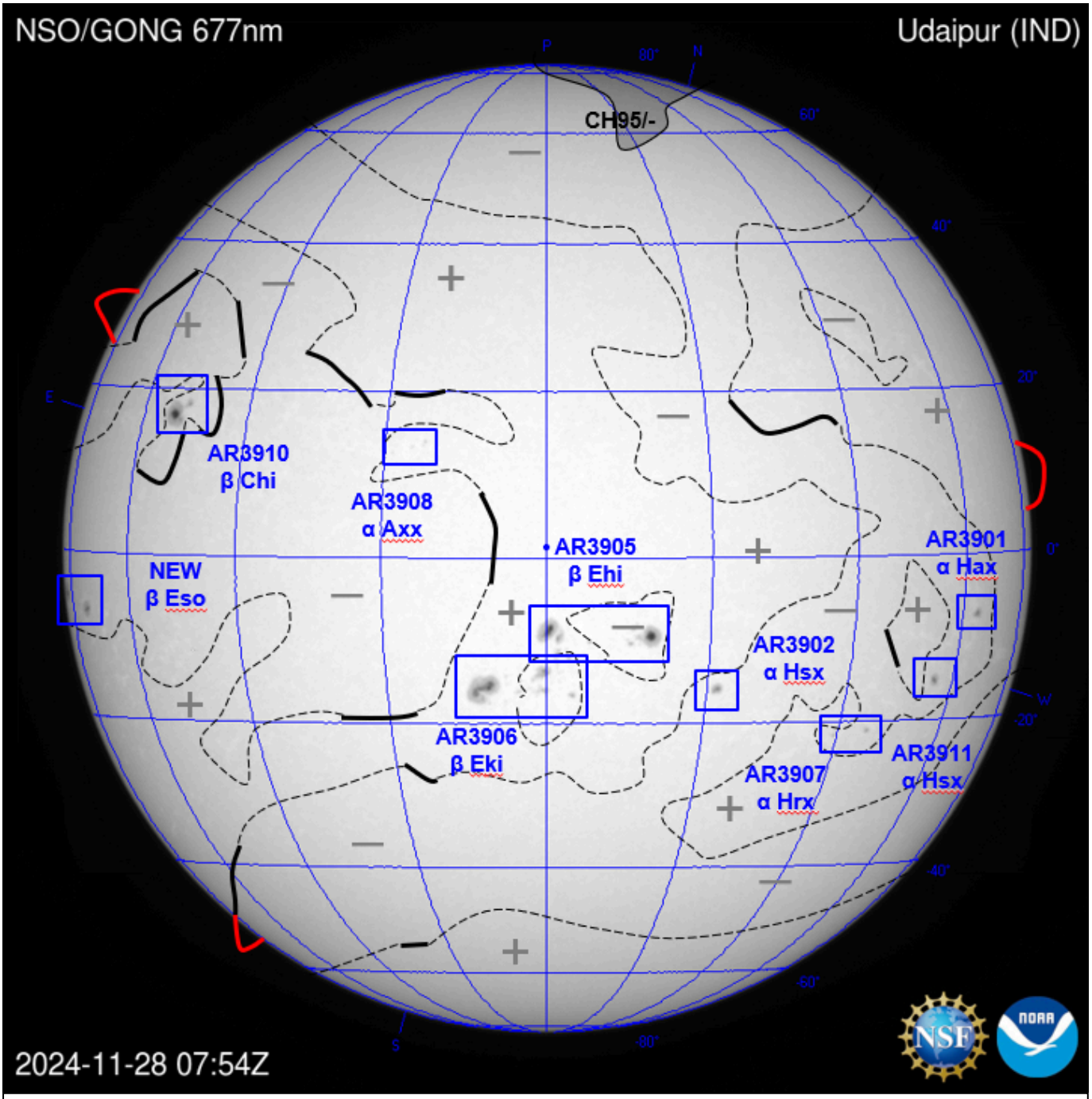
Solar Wind / Geomagnetic Activity: A CME from the filament eruption on 25 Nov is expected to arrive on Day 1 or early Day 2 (28-29 Nov), but low confidence on timing and impact of this feature, with the bulk of its material passing south and east. Otherwise, mainly background winds are expected. Initially Quiet geomagnetic activity, but with a likelihood of a period of Active to G1 Minor Storms from the CME arrival on Day 1 into Day 2. There is slight chance of G2 Moderate Storms. CME enhancements then easing with mainly Quiet to Unsettled conditions following.

Energetic Particles / Solar Radiation: High energy protons are expected to persist at background levels but with a slight chance of rising in response to any notable flares. High energy electron flux is expected to persist at mainly background levels with the associated 24 hour fluence remaining below the Active threshold.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 1: Solar synoptic map, valid 28/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Geomagnetic Storms

There are a couple of CMEs of interest. The most notable is from the filament eruption around 25/2030 UTC. The majority of the ejecta is directed south and east, however a partial halo shock component is also evident. There is a moderate confidence for at least a glancing impact on Day 1 (28 Nov), or perhaps early Day 2 (29 Nov), however the timing of this is low confidence due to MOSWOC Enlil currently providing poor guidance as it is significantly over-estimating the current wind speeds. In addition, no arrival has been seen yet at Solar Orbiter, which is currently between Earth and the Sun and is likely to see the CME before Earth does.

The second CME, due to a filament eruption from the southeast disc around 27/1850 UTC, has now been analysed. This is slow and mostly travelling below Earth's orbit, but may give a glance after the end of this period, on 02 Dec. It is likely to be quite weak by that time, however.

While a number of other CMEs have been observed on previous days these are either missing Earth, or are narrow, slow and expected to give minimal impacts given their trajectory. No coronal hole fast winds are expected during this period.

Geomagnetic activity is expected to be mainly Quiet (Kp 0-2) at first. The CME arrival on Day 1 is likely to bring Active to G1 Minor Storms, with a slight chance for isolated G2 Moderate Storm intervals. This most likely if any prolonged negative (southward) orientated north-south component of the IMF is observed with any magnetic cloud that follows the arrival. Any enhancement is expected to ease later on Day 2, with mainly Quiet to Unsettled conditions following, with only a slight chance of Active intervals. Any glancing impact from the second CME may give a slight chance of G1/Minor Storm intervals on 02 Dec (after Day 4).

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	60	40	1	1
Strong	**G3**	No	5	5	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

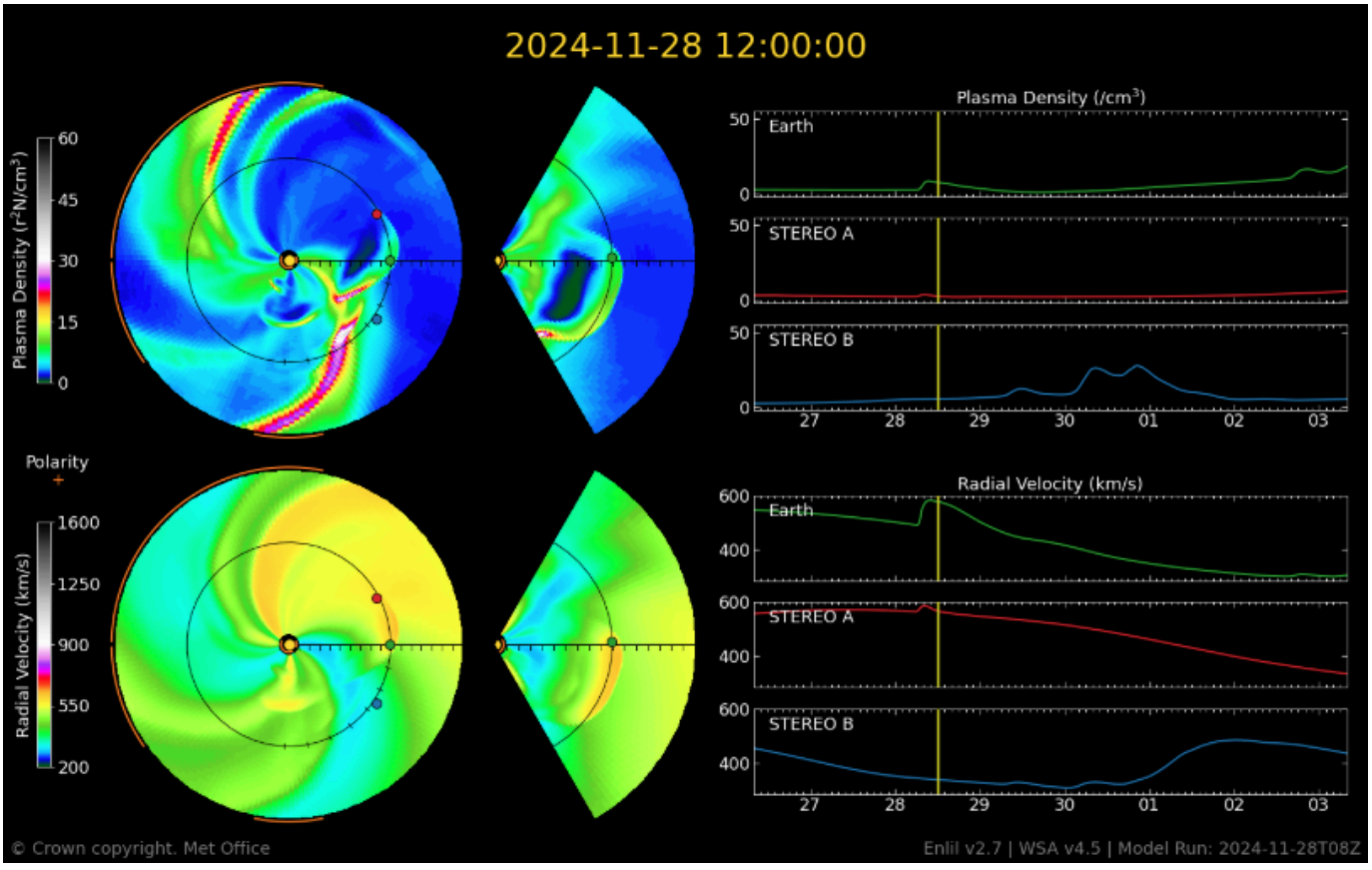
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
25/11/2024 20:30	Partial	AR3901	SE	950	28/11/2024 07:00 UTC	More likely to be later than original forecast.
28/11/2024 04:28	Partial	Filament	SE	390	02/12/2024 12:00 UTC	Low confidence glancing blow.

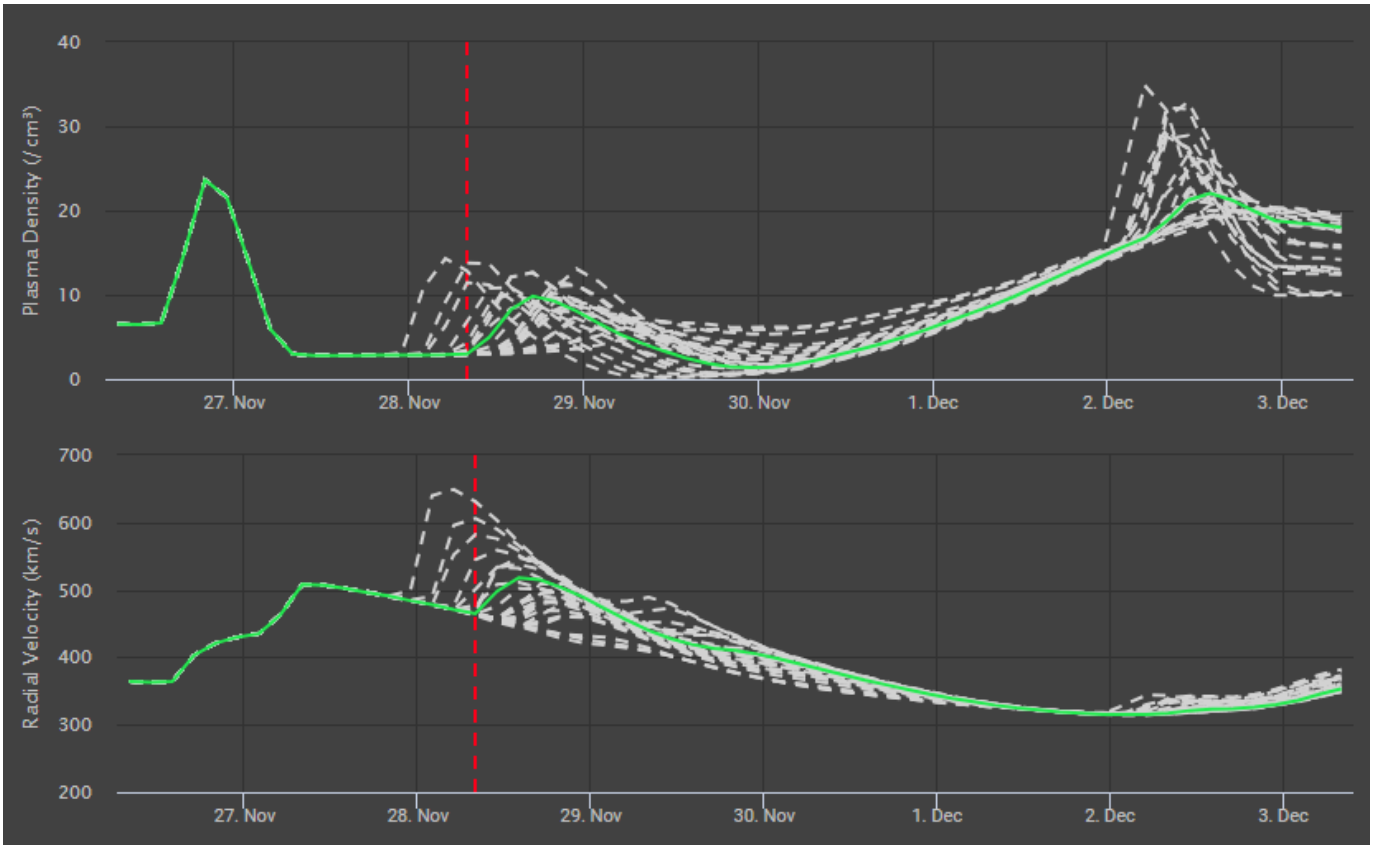
Figure 2: MOSWOC Enlil, with wind speeds much higher than those observed at L1. As such the CME arrival is likely to be delayed from that suggested by Enlil.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 3: Enlil ensemble, showing risk of CME arrival today / tomorrow, and again on 02 December.



© Crown Copyright 2024. All Rights Reserved.

Radio Blackouts - X-Ray Flares

Low to Moderate activity is expected with isolated M-class flares likely, and a slight chance of X-class flares.

There are nine active regions currently on the Earth-facing disc. The largest of these are AR3905 and AR3906 in centre disc, with some interaction likely between the two regions, however these have remained relatively inactive. Also of note is AR3910 in the northeast, which was the source of an M9 flare from over the northeast limb. This appears to be a relatively simple group, dominated by a main spot, with much smaller satellites, however this remains difficult to assess due to its location. A new region emerging onto the southeast limb may be one region or two separate regions - for the time being it is classified as one region but this may change as it moves into a clearer viewing angle. The other regions are generally smaller and simpler, with no sign of notable growth or development. Assessment of sunspot regions is currently more difficult than usual with limited imagery due to the fact that SDO data is down.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	60	60	60	60
Very Active	R3-R5 (X Class)	No	10	10	10	10

Figure 4: X-ray flux at GOES16 and 18.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

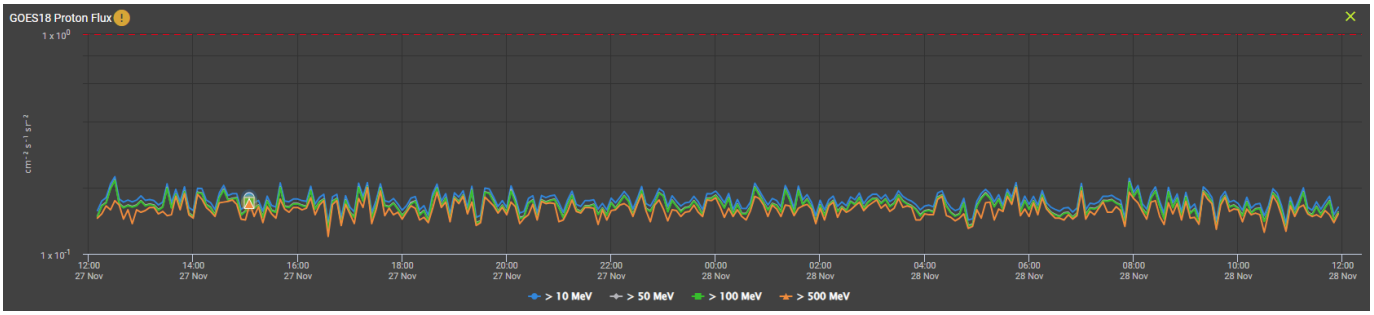
© Crown Copyright 2024. All Rights Reserved.

Solar Radiation Storms (High Energy Protons)

GOES-18 Proton flux is at background levels. There are a number of active regions currently on the disc, with the largest of these situated in the south-centre disc and soon to move into the southwestern quadrant, increasing their potential connectivity. However, despite being moderately sized, the regions remain magnetically simple, and subsequently only have a slight chance of observable high energy protons being ejected from any larger flare that does occur.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: Proton flux at GOES18.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

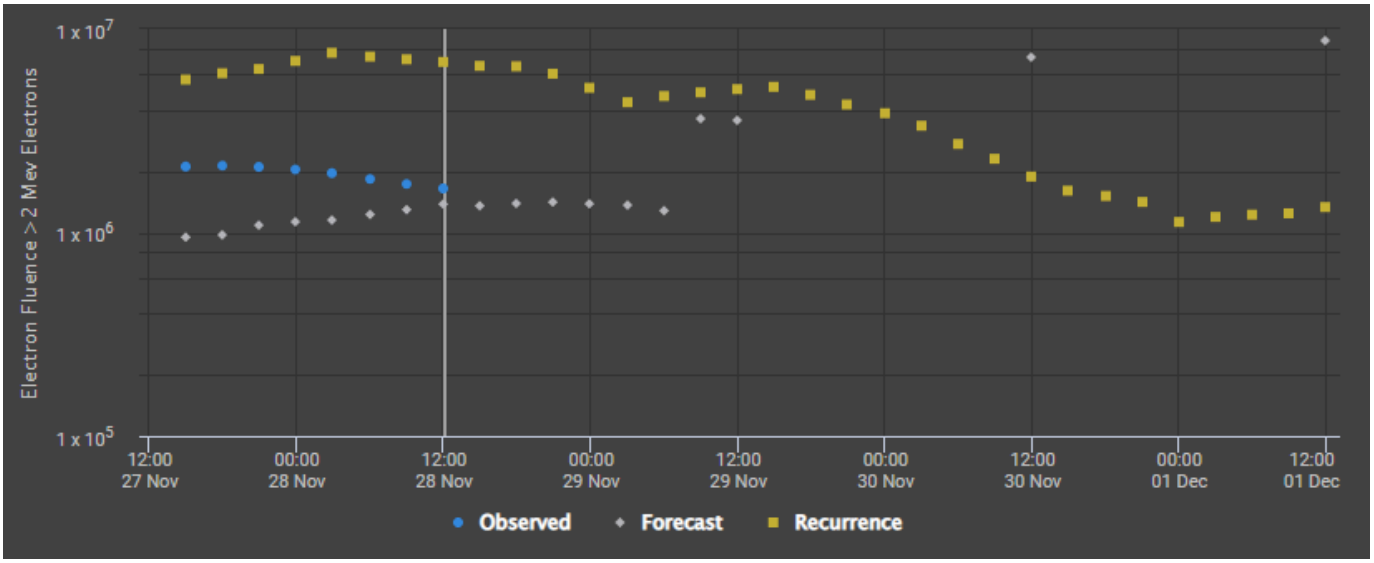
High Energy Electrons (≥ 2MeV)

High energy Electron flux observed by GOES-16 is at background levels, with no significant enhancements currently anticipated. The expected CME arrival on Day 1 or Day 2 (28-29 Nov) is not expected to have a notable impact on the observed flux levels at GEO.

The associated 24 hr fluence is expected to persist below Active, with MOSWOC REFM currently providing good guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 6: MOSWOC REFM showing a forecast well below Active, which is considered good guidance at present.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.